

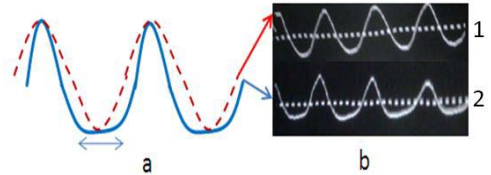
## Respiratory Rate Regulation for optimal Time-SLIP imaging of renal arteries

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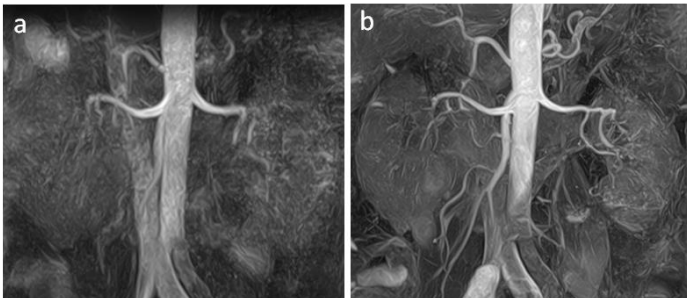
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**Introduction:** Respiratory gated non contrast enhanced MR angiography using Time-Spatial inversion labeling pulse (Time-SLIP) [1,2] is a well established technique at our institution for the exploration of renal arteries [3,4]. Since 2007, we scanned more than 450 patients with age ranging for 18 to 92 year old. Patients with fast and/or irregular respiration rates (RR) can be very challenging to image. Most of the difficult patients are old (80+), or have a cardiac disease and/or a respiratory disease. A breath hold of more than 16s is intolerable for most of these patients. We describe how regulating the respiratory rate can significantly improve the image quality and the success rate of Time-SLIP.

**Material and Methods:** All MR images were obtained on a 1.5T MRI system (Vantage, TOSHIBA, Tokyo). We used Time SLIP with balanced SSFP, respiratory-gated triggered on expiration and the following parameters: TR=5.2 ms, TI=1200 to 1800 ms, TE=2.6 ms FA 120, FOV 35x35 cm, Matrix 256X256, Speeder Factor 2, slice number =35, Fat Sat ON, and typical time =4.30 min. In 2007 we scanned 105 patients with free breathing. In 2008 we started regulating the breathing by instructing the patients to breath calmly and regularly by listening to a recorded voice (“inhale ... exhale”), bringing the RR to 10 rpm. We refer to the Regulated Respiratory Rate acquisition by R<sup>3</sup>-Time-SLIP. In



**Fig 1:** Regulated Respiration Rate. (a) At a same respiration rate a faster expiration provides an optimal plateau for image acquisition. (b) patient respiration trace for R<sup>3</sup> (1) and R<sup>3+</sup> (2).



**Fig 2:** MIP of coronal Time-SLIP acquisition (a) Free breathing (b) Optimized Regulated-Respiratory-Rate (R<sup>3+</sup>).

2008 we switched from free breathing acquisitions to R<sup>3</sup>. We scanned a total of 180 patients. In 2009 we further optimized the technique by accelerating the expiration phase bringing the expiration trace to a plateau of 3-4 seconds (fig1). We refer to this last technique by R<sup>3+</sup>. The image quality of the native images and the Maximum Intensity Projections (MIPs) in several planes was visually

assessed by an experienced radiologist and scored

as: Poor interpretable, moderate but interpretable or excellent quality.

**Results:** A summary of the image quality scores is given in table 1. Regulating the RR improved significantly the image quality and the success rate of Time-SLIP (Fig2). Since 2008 more than 95% of our images are diagnostic and in 2009 we further improved it to 98 %.

**Conclusion:** Free breathing acquisition can be sub-optimal in the elderly patients and/or patients with severe cardiac or respiratory problems. Breath hold acquisition could be a sustainable solution for all patients if the breath hold does not exceed 16-18s however this is currently possible only by trading off image resolution. R<sup>3+</sup> is a good compromise that is tolerated by all patients. Further more, It is very easy to implement.

**References:** 1. Miyazaki M, Lee V.S, Radiology 2008 Jul;248(1):20-43. 2. D. Utsunomiya et al. *Circ J* 2008; 72: 1627–1630. 3. I. Parienty et al ISMRM’08, Toronto. 4. I. Parienty et al, ISMRM’09 Hawaii.

**Table 1:** Image quality scores

	2007	2008	2009
<b>N Patients</b>	105	180	176
<b>Poor</b>	20%	5%	2%
<b>Moderate</b>	50%	25%	17%
<b>Excellent</b>	30%	70%	81%